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<b>(54) Title:</b> BUOYANT AND/OR THERMALLY INSULATING ARTICLES			
<b>(57) Abstract</b>  The invention relates to the use of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer in the manufacture of articles particularly to provide or enhance buoyancy and/or thermal insulating properties of the article. In particular the invention provides an article (such as an item of clothing) fabricated substantially from a textile or similar flexible material at least a portion of which supports one or more layers of the sheet material.			

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## **BUOYANT AND/OR THERMALLY INSULATING ARTICLES**

The present invention relates to buoyant and/or thermally insulating articles, particularly, but not exclusively, textile and similar fabric based articles such as articles of clothing.

It is known to provide outdoor garments and survival aids (such as buoyancy aids) which incorporate a foam material to enhance buoyancy and/or thermal insulation. Various foam materials have been used for such applications, such as closed-cell polyvinyl chloride and polyethylene foams. In conventional constructions the foam is provided as a lining/filler material in a relatively thick, and thus rigid, layer or panel. For instance, a typical life jacket will incorporate front and back panels of a polyvinyl chloride foam of a thickness the order of 1cm or thicker. Such foam linings/fillings must be relatively thick in order to meet stringent quality and safety standards. For instance, buoyancy aids such as life jackets marketed in Europe have to meet strict mechanical and thermal compressibility standards relating to the loss of buoyancy as a result of mechanical compression (over a given duration of time) or thermal compression resulting from exposure to extreme temperature variations.

The required thickness of the foam lining makes such conventional products relatively bulky and cumbersome, restricting the manoeuvrability of the wearer. This can be a significant disadvantage, particularly in relation to products for use in survival situations in which manoeuvrability in adverse conditions can be extremely important.

Buoyant garments are available which incorporate a lining comprising multiple layers of a thin foam material, rather than a single relatively thick layer which as a result are less cumbersome. However, the foam materials used in such garments, which are layers of a thin (of the order of 1.5mm thick) closed-cell polyethylene foam, do not provide the same level of resistance to mechanical and thermal compressibility as the conventional products mentioned above. Indeed such products do not meet the stringent European and International safety standards. In addition, the thin foam materials are relatively low strength and are thus relatively

easily ripped and torn and cannot, for instance, properly sustain stitching. Accordingly, such garments are not suitable for serious safety applications.

It is an object of the present invention to obviate or mitigate the above disadvantages.

In its broadest aspect the present invention relates to the use of a relatively thin sheet material in the manufacture of various articles (in particular to provide or improve buoyancy and/or thermal insulating properties), the sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer.

Thus, according to one aspect of the present invention there is provided an article fabricated substantially from a textile or similar flexible material at least a portion of which supports a plurality of layers of said sheet material.

According to a further aspect of the present invention there is provided a buoyant and/or thermally insulating article comprising multiple layers of a said sheet material secured together adjacent one another.

The essence of the present invention is the use of a foam based sheet material which has good buoyancy and thermal insulating properties and which has a laminated structure being provided with at least one protective layer which strengthens the material. This overcomes the disadvantages associated with the thin foam materials previously used. That is, even if constructed to relatively thin dimensions the material may retain good tear and puncture resistance as well as good resistance to loss of buoyancy and thermal insulation properties as a result of mechanical or thermal compression. Moreover, the strength of the material renders the material relatively robust so that it is easily workable and may readily be cut and sewn without tearing or puckering. Thus, the sheet material in accordance with the present invention offers the advantages of thin foam materials used in the prior art (in that it can be used in relatively thin sheets resulting in products which are less cumbersome than, for instance, conventional buoyancy aids and similar products) whilst suffering none of the associated disadvantages.

Moreover, by incorporating a sufficient number of layers of the sheet material, the resultant article can have buoyancy and thermal insulating properties which are as good as, or exceed, those of conventional products based on thick layered foam

fillings. Buoyancy and/or thermal insulating properties can readily be varied simply by varying the number of layers of the sheet material included in any particular article. In a multi-layer construction, not only does each individual layer contribute to buoyancy and thermal insulation, but the buoyancy and thermal insulation of the article as a whole is improved by pockets of air trapped between individual layers of the sheet material.

The sheet material preferably has a thickness of less than 6mm. For instance, the thickness may preferably be between 0.3mm and 4mm, and most preferably between 0.5mm and 1.5mm (for instance of the order of about 0.7mm).

The sheet material preferably comprises a single layer of said relatively low density foam with a protective layer laminated to one or both sides thereof. The foam layer should preferably be thicker than the or each protective layer.

The foam layer may comprise any foam material having buoyant and/or thermally insulating properties and is preferably a closed-cell foam such as polyethylene, polypropylene or polyvinyl chloride. The foam layer preferably has a density in the range 10-40Kg/m, more preferably in the range 15-30Kg/m and most preferably in the range 20-24Kg/m.

The or each protective layer may comprise a variety of different materials, and where the sheet material comprises more than one such protective layer, each protective layer may be fabricated from a different material. Examples of suitable materials for use as the protective layer are a relatively high density polyethylene or polypropylene film, a foil or other reflective material such as metalised polyester (which will enhance the thermal insulating properties of the material), or a non-woven, woven or knitted textile substrate.

The or each protective layer may be laminated to the foam layer using a conventional process appropriate to the particular materials. For instance, where the foam material is a polyethylene foam, and a protective layer is a polyethylene film,

the protective layer may be laminated to the foam layer by a conventional heat-bonding process.

The thickness of the or each protective layer may be varied to suite individual applications. For instance, a polyethylene or polypropylene protective layer may be of the order of 10-25 $\mu$ m thick.

The sheet material may be adapted to be breathable. For instance the foam layer could be perforated (for instance "pin holed" using a hot needle or punching process) to provide breathable properties, and the or each protective layer could comprise of a breathable material, such as a hydrophilic or micro-porous membrane. Alternatively the protective layer could comprise an essentially non-breathable material but which is rendered breathable by treatment together with the foam layer by, for instance, "pin holing".

A wide variety of articles may be fabricated in accordance with the present invention. The invention is, for instance, applicable to all forms of clothing, particularly outdoor clothing, examples of which are swim-wear, ski and mountaineering wear, rain-wear, wet-suits, dry-suits, immersion suits, headgear, gloves and footwear such as shoes, boots and in-soles. The invention is also particularly applicable to buoyancy and survival aids such as life jackets/vests, survival suits, and life boats/rafts. The invention is applicable to all articles which might conceivably benefit from enhanced buoyancy or thermally insulating properties, miscellaneous examples of which are tents, sleeping bags, back packs, blankets, hold alls, and wrappings for the protection of materials and appliances such as construction materials, flooring such as carpet underlay, swimming pool covers (for example a swimming pool cover of the foam laminate provided with a metalised polyester layer - facing the water - would allow UV light to pass through and heat the water which would be insulated by the foam and reflective layer), and hot air balloons (to help keep the air inside the balloon warm, particularly at high altitudes).

It will be appreciated that the variety of articles to which the invention may be applied is very wide and that the list given above is non-exhaustive.

For instance, sheet materials in accordance with the present invention may be used for lining/insulating refrigeration units, particularly mobile refrigeration units, where use of the material in accordance with the present invention in place of



conventional materials could reduce the weight of the refrigerating unit. For example, conventional refrigerated vehicle trailers have a wall including a large air gap to provide insulation. Installation of a sheet material in accordance with the present invention within the air gap would improve insulating properties so that the gap could be smaller allowing the size of the refrigerated storage area to be increased. Similar applications are refrigerated tankers, such as are used to transport milk and similar products.

Materials in accordance with the present invention may also have applications in the manufacture of articles which are not necessarily required to be buoyant or thermally insulating. For instance, the material could advantageously be used in the manufacture of safety airbags such as are commonly installed in road vehicles. The foam layer will provide good cushioning whilst the protective layer will provide the required strength. Such an airbag could readily be manufactured from circular sheets of the sheet material (which for instance may be die cut) which are then joined at their edges by any appropriate technique such as heat welding, radio frequency or other thermal fusing methods.

The relatively thin sheet material in accordance with the present invention has a particular advantage over thicker materials previously used in buoyant clothing in that it can readily be distributed as a lining throughout the whole of a garment whilst substantially retaining the drape properties of the garment outer fabric. Thus, a greater portion of the article can be provided with the buoyant material than may be the case using conventional relatively thick foam panels. The thin sheet material may, for instance, be used as a lining for relatively fashionable articles of clothing.

Garments constructed in accordance with the present invention provide both buoyancy and thermal insulation which may eliminate the need to wear additional bulky safety or protective clothing. Rather, garments in accordance with the present invention may be extremely lightweight providing the wearer with a combination of comfort and manoeuvrability together with high levels of safety and thermal insulation which is not achievable with the conventional garments mentioned above.

Specific embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 illustrates a women's swim-suit in accordance with the present invention; and

Fig. 2 illustrates part of a lining of the swim-suit of Fig. 1.

Referring to Fig. 1, the illustrated swim-suit, which is of a conventional women's pattern, comprises front and back panels 1 and 2 stitched together along their edges by stitching 3. Each panel comprises outer and inner plys of conventional material, such as a cotton or polyester material, provided with a buoyant lining in accordance with the present invention.

Fig. 2 illustrates the lining of one panel of the swim-suit. The lining comprises fifteen layers of a buoyant sheet material (described in more detail below) laid one on top of the other and cut to the appropriate shape. More or less layers can be provided depending on the required buoyancy. The lining is either stitched into the front panel or simply sandwiched between the inner and outer plys in accordance with conventional clothing manufacturing techniques.

The preferred form of the sheet material is a 0.7mm thick sheet of low density closed-cell polyethylene (or polypropylene) foam with a 10 to 25 $\mu$ m thick film of relatively dense non-foamed polyethylene (or polypropylene) laminated thereto by a heat-bonding process. The material may be perforated to provide breathable properties.

This material is extremely lightweight and flexible (even when provided in 15 layers) whilst having excellent buoyancy and thermally insulating properties (the material meets current European standards of resistance to mechanical and thermal compressibility). The material has a number of other beneficial properties. For instance, it is waterproof, wind proof, resistant to rot, soft to the touch and non-abrasive; it retains its shape and recovers its shape well when deformed; and it does not lose its buoyancy even if ripped. In addition, the multi-layer structure is an excellent padding, providing cushioning for the wearer giving protection against knocks.

About 170grams of this material sewn into a garment (not necessarily a swim-suit as illustrated) can keep afloat a person weighing of the order of 98 kilo grams. The material also has excellent thermal properties, due to its extremely low thermal conductivity, providing protection against temperatures as low as -25°C. It will thus



be appreciated that this material is not only suited to swim-wear but also to a wide variety of clothing and buoyancy aids and indeed any article which benefits from buoyancy and/or thermally insulating properties.

For instance, whilst the illustrated swim-suit is particularly suited for wear by children and/or adults when learning to swim, it may also be used as a safety garment for use in relation to water sports such as sailing, water-skiing, wind surfing, etc. Similarly, other types of clothing could be manufactured in the same way, for instance life jackets and similar buoyancy aids.

Whilst the lining material is particularly useful in articles requiring enhanced buoyancy, the material may also be used in articles requiring good thermal insulation but not necessarily requiring buoyancy. Tests have shown that the above material in accordance with the present invention has thermal insulating properties that are significantly superior to existing thin insulating materials such as the well known Thinsulate (trade mark) material manufactured by 3M. For instance, tests comparing the thermal insulating properties of the material in accordance with the present invention at thicknesses between 3 and 10 millimetres have shown the material to have approximately twice the TOG value of Thinsulate of a corresponding thickness.

The material described above can for instance be used as a lining for winter sports wear such as ski-wear. Similarly, the material may be used as a lining for sleeping bags, tents and survival gear. In such applications it may be preferable to provide the material with a layer comprising a highly reflective metalised material (either instead of, or in addition to, the polyethylene film) to increase thermal insulating properties.

Other non-exhaustive examples of articles to which the present invention may be applied are given above together with possible alternatives for the sheet material.

### CLAIMS

1. The use of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer in the manufacture of articles to provide or enhance buoyancy and/or thermal insulating properties of the article, wherein said at least one protective layer comprises non-foamed polyethylene or polypropylene.
2. An article fabricated substantially from a textile or similar flexible material at least a portion of which supports one or more layers of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer, wherein said at least one protective layer comprises non-foamed polyethylene or polypropylene.
3. The use of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer in the manufacture of articles to provide or enhance buoyancy and/or thermal insulating properties of the article, wherein said at least one protective layer provides the laminate with a reflective surface.
4. An article fabricated substantially from a textile or similar flexible material at least a portion of which supports one or more layers of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer, wherein said at least one protective layer provides the laminate with a reflective surface.
5. The use of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer in the manufacture of articles to provide or enhance buoyancy and/or thermal insulating properties of the article, wherein said at least one protective layer comprises a breathable material.
6. An article fabricated substantially from a textile or similar flexible material at least a portion of which supports one or more layers of a sheet material comprising a

laminate of a relatively low density foam and at least one relatively high density protective layer, wherein said at least one protective layer comprises a breathable material.

7. The use of a plurality of adjacent layers of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer in the manufacture of an article, particularly to provide or enhance buoyancy and/or thermal insulating properties of the article.

8. An article fabricated substantially from a textile or similar flexible material at least a portion of which supports a plurality of adjacent layers of a sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer.

9. A buoyant and/or thermally insulating article comprising two more layers of a sheet material secured together, the sheet material comprising a laminate of a relatively low density foam and at least one relatively high density protective layer.

10. An article according to any preceding claim, wherein said sheet material has a thickness of less than 6mm.

11. An article according to claim 10, wherein said sheet material has a thickness between 0.3mm and 4mm.

12. An article according to claim 11, wherein said sheet material has a thickness between 0.5mm and 1.5mm.

13. An article according to claim 12, wherein said sheet material has a thickness of the order of about 0.7mm.

14. An article according to any preceding claim, wherein the sheet material comprises a single layer of said relatively low density foam with a protective layer laminated to one or both sides thereof.
15. An article according to any preceding claim, wherein the foam layer of said sheet material is thicker than the or each protective layer.
16. An article according to any preceding claim, wherein the or each foam layer has a closed-cell structure.
17. An article according to claim 12, wherein the or each foam layer comprises a closed-cell low density polyethylene or polypropylene foam.
18. An article according to any preceding claim, wherein a protective layer comprises a thin film of relatively high density non-foamed polyethylene or polypropylene.
19. An article according to 18, wherein said polyethylene or polypropylene film has a thickness in the range of 10 $\mu$ m to 25 $\mu$ m.
20. An article according to any preceding claim, wherein the sheet material comprises a protective layer of a reflective material such as a metal foil or a metalised polyester.
21. An article according any preceding claim, wherein the sheet material comprises a protective layer of a woven, non-woven or knitted textile.
22. An article according to any preceding claim, wherein the sheet material is breathable.

23. An article according to any preceding claim, wherein the or each protective layer comprises a breathable material such as a hydrophilic or micro-porous membrane.
24. An article according to any preceding claim, comprising between 2 and 20 layers of said sheet material.
25. An article according to any preceding claim, wherein the article is an article of clothing or footwear or any article intended to protect a human being.
26. A buoyant and/or thermally insulating article, substantially as hereinbefore described, with reference to the accompanying drawings.

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